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Ferroelectricity Newsletter

A quarterly update on what's happening in the field of ferroelectricity

Volume 6, Number 2 Spring 1998

SELECT YOUR FAVORITE TIDBITS FROM THIS ISSUE'S SMORGASBOARD OF INFORMATION

For all those ferroelectricity experts and enthusiasts who did not have the opportunity to attend the **10th anniversary meeting of ISIF** last March in Monterey, California, the detailed conference report by Technical Program Co-Chairperson **Orlando Auciello** will be a welcome source of information about this important event. The write-up starts on page 2 of this issue. For a list of ISIF98 presentations, please consult the previous issue (Winter 1998) of the *Ferroelectricity Newsletter*.

In our **Papers** section you will find titles and authors of presentations given at three different events:

- COST 514 ACTION Workshop on Ferroelectric Thin Films, 14-15 April 1997, Parma, Italy
- 16th Conference on Crystal Growth and Epitaxy, 7-10 June 1998, Fallen Leaf Lake, California, USA
- 1997 Williamsburg Workshop on Ferroelectrics 2-5 February 1997, Williamsburg, Virginia, USA.

Don't miss the information on page 11 regarding the database used in **Professor Sidney B. Lang's "Guide to the Literature of Piezoelectricity and Pyroelectricity"** which appears semiannually in *Ferroelectrics* and is now available on the Gordon and Breach Internet website.

Upcoming meetings featured in this issue include:

- **IEEE Conference on Electrical Insulation and Dielectric Phenomena** (page 12)
- **Session EM12: Processing of High Dielectric Constant Materials for DRAMs** of the 45th International Symposium of the American Vacuum Society (page 12), and
- **Micro System Technologies 98: 6th International Conference and Exhibition on Micro Electro, Opto, Mechanical Systems and Components** (page 13).

The section on publications (page 14) gives you information on new releases of the Materials Research Society, discussing low-dielectric constant materials, magnetic ultrathin films, and polycrystalline thin films, among others.

As always, we invite your contribution about your particular field of interest in the ever expanding area of ferroelectricity.

Rudolf Panholzer
Editor-in-Chief

IN THIS ISSUE

Ferroelectricity Newsletter

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COST 514 PAPERS

*The following is a list of titles and authors of presentations given at the **COST 514 ACTION Workshop on Ferroelectric Thin Films**, held on 14-15 April 1997 in Parma, Italy. This meeting was the fourth in a series of workshops sponsored by the EC COST Action.*

Film Deposition, Processing, and Integration

$Pb(Zr,Ti)O_3$ thin film fabrication: Process modifications for different applications

B.A. Tuttle, P.G. Clem, T.J. Garino, H.R. Ruffner, M. Rodríguez, D.R. Tallant, D. Dimos, and C.J. Brinker

PLZT 4/65/35 thin films prepared by acetic-acid based sol-gel route

B. Malic, N. Setter, M. Kosec, K. Brooks, and G. Drazic

Characterization of ferroelectric thin films by X-ray diffraction and electron microscopy

A. De Benedittis, A. Di Cristofero, G. Majni, and P. Mengucci

Microelectronic Applications and Integration

Recent progress in the research and development of ferroelectric memory in Japan

T. Shiosaki

Control of texture and oxygen stoichiometry in reactively sputtered RuO_2 electrode layers for low fatigue PZT FECAPs

G.J. Norga, D.J. Wouters, T. Connard, and H.E. Maes

Ferroelectric device development at GEC-Marconi

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10TH ANNIVERSARY INTERNATIONAL SYMPOSIUM ON INTEGRATED FERROELECTRICS

The 10th Anniversary of the International Symposium on Integrated Ferroelectrics was a witness to the tremendous progress on the basic and applied science of ferroelectric thin films experienced in the last ten years. In view of the work reported at the ISIF98, it is appropriate to say that ferroelectric thin films is one of the fast evolving interdisciplinary fields of research worldwide.

A major driving force for the extensive research being performed in many universities, industrial, and national laboratories around the world is the promise of a variety of applications in a whole new generation of advanced microdevices that may revolutionize various technologies and create new multibillion dollar markets. The work reported at the ISIF98 shows that ferroelectric thin films are being integrated with semiconductor devices to fabricate and commercialize low density nonvolatile ferroelectric random access (NVFRAMs) memories with long endurance and high speed access, which can overcome the problems encountered in current semiconductor and magnetic memory technologies. However, work on integration is still needed to produce commercial high density memories. Scientists have also made major advances in research focused on the integration of high dielectric constant thin film capacitors with semiconductor devices for manufacturing high density dynamic random access memories (DRAMs). Ceramic conductors can be applied to ohmic, voltage-dependent, and thermally sensitive resistors, fast-ion conductors, humidity and gas sensors. Piezoelectricity is being exploited in micromachines, such as accelerometers, displacement transducers, and actuators, such as those required for inkjet printers, for video-recording head positioning and for micromachining. Pyroelectricity can be utilized in the fabrication of high sensitivity room temperature infrared detectors, while electrooptic activity can be used in color filter devices, displays, image storage systems, and optical switches for integrated optical systems. The applications of electroceramic thin films mentioned above are only a part of a more extensive list, which indicates the relevance of these materials in the new technological era of modern society. Substantial progress has been made in the field of synthesis and processing of electroceramic thin films and implementation into prototype devices. In addition, new techniques have been developed to perform *in situ* or *in situ* real-time characterization of film growth and device-related processes. However, there are still some critical materials and device integration issues that need to be solved for the realization of the high impact commercial devices.

The ISIF98 ran for three-and-a-half days in March 1998, including a tutorial session on Sunday, 1 March, and 20 scientific sessions from Monday, 2 March to Wednesday, 4 March. Forty-eight participants attended the following tutorial sessions given by experts in the field of ferroelectric thin films and device integration: "Ferroelectrics and related materials" by Susan Trolier-McKinstry (Pennsylvania State University); "Ferroelectric thin film

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processing" by Bruce Tuttle (Sandia National Laboratory); "Process integration" by S. Traynor (Ramtron); and "What are we looking for?" by Joe Evans (Radiant Technologies, Inc.). The scientific program was organized in several parallel sessions, which were preceded every day by a plenary lecture session. Poster sessions were organized on Monday and Tuesday afternoon. In addition, there was an equipment and instrumentation exhibit which featured film deposition and characterization systems relevant to the field of ferroelectric thin films and related devices. The ISIF98 established a new record for both submitted abstracts (193) and participants (277).

FIRST DAY

The first day of the conference included a plenary session in the morning, followed by parallel sessions on "Testing and Characterization," "Device Integration Issues," "DRAMs and Materials," and a poster session in the afternoon. The state of the art on the science and technology of $SrBi_2Ta_2O_9$ (SBT) and $Pb(Zr_xTi_{1-x})O_3$ (PZT) based capacitors for nonvolatile ferroelectric memory applications were discussed in two plenary lectures. These reviews indicate that both SBT and PZT based capacitors exhibit negligible fatigue and imprint and memory-compatible polarization retention and leakage current. The main difference being that SBT capacitors exhibit the above mentioned properties when integrated with Pt electrodes, while PZT-based capacitors need conductive oxide electrodes or hybrid Pt/conductive oxide electrodes.

Device Integration Issues

The session on device integration issues revealed that researchers are turning their focus to investigating more closely issues critical to the fabrication of ferroelectric memories. For example, various papers discussed the effect of N_2-H_2 forming gas anneal on the properties of Pt/PZT/Pt capacitors. Annealing in N_2-H_2 atmospheres results in a substantial decrease in the capacitor polarization and mechanical degradation of the Pt electrodes. The damage produced by the forming gas anneal can be eliminated by an annealing step in an oxygen atmosphere. Papers on reactive ion etching of PZT indicate that ion bombardment-induced damage on the edges of the capacitor structure may result in degraded properties on submicron capacitors as opposed to larger capacitors. These results make imperative that researchers direct more effort to investigating reactive ion etching processes of ferroelectric thin films. On the other hand, new results on etching of Pt electrodes demonstrated that very thin hard masks can be used to produce Pt patterned top electrodes without fencing. Work was also reported on barriers and electrodes for SBT and PZT based capacitors. TaSiN and TiAlN appear to be promising barriers, while Ir and Ir/IrO_2 hybrid electrodes appear as suitable alternatives to Pt electrodes. However, further work on these materials is necessary to determine their suitability for integration into memories.

DRAMs and Materials

The session on DRAMs revealed that although the properties of CVD-BST films have been greatly improved, there is still much to be understood about

COST 514 PAPERS

P. Kirby, R. Wright, T. Langley, A. Patel, and J. Sabir

Pulsed Laser Deposition

Pulsed laser ablation and deposition of PZT-based multilayers
F. Fuso, L. Ceresara, A. Iembo, E. Arimondo, F. Neri, G. Mondio, and M. Allegrini

On the preparation and characterization of PLZT thin films grown by pulsed laser deposition
M.J. Matos Gomes and P. Vilarinho

A practical interlayer dielectric process for integrated ferroelectric capacitors
L. Boyer, J.T. Evans, Jr., R. Suizu, and N. Velasquez

Nonswitching Applications

Conditioning treatments on $(Pb,Ca)TiO_3$ thin films
M.L. Calzada, P. Ramos, M.J. Martin, and J. Mendiola

Ferroelectric and pyroelectric properties of lithium tantalate ($LiTaO_3$) thin films
C.H. Kohli, P.E. Schmid, and F. Lévy

Microstructures and properties of La-modified lead titanate sol-gel processed thin films
L. Pardo, M. Algueró, and M.L. Calzada

Correlation between deposition conditions and defect structures in sol-gel lead zirconate titanate films
B.E. Watts, F. Leccabue, E. Melioli, G. Bocelli, C. Morandi, and G. Chiorboli

COST 514 PAPERS

Optical Properties and Other Issues

Composition-structure-properties relationships in ferroelectric thin films

A. Sternberg, M. Tyunina, M. Kundzinsh, V. Zauls, M. Ozolinsh, K. Kundzinsh, I. Shorubalko, M. Kosec, L. Pardo, M.L. Calzada, M. Algueró, R. Kullmer, D. Bäuerle, J. Levoska, S. Leppävuori, and T. Martoniemi

Far IR spectroscopy of ferroelectric thin films

I. Fedorov, V. Zelezny, and J. Petzelt

Zirconium titanate ceramics via polymeric precursor

A. Bianco and G. Gusmano

16TH CONFERENCE ON CRYSTAL GROWTH AND EPITAXY

The following is a list of presentations given at the 16th Conference on Crystal Growth and Epitaxy, to be held 7-10 June 1998 at Stanford Sierra Camp, Fallen Leaf Lake, California, as published in the advance program. The conference is sponsored by the American Association for Crystal Growth/ Western Regional Section. No formal written proceedings will be published beyond a compilation of all abstracts.

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the dielectric and electrical behavior of BST-based capacitors. A substantial amount of information has been obtained on the effect of capacitor structure, electrode and barrier materials, film deposition techniques, and annealing sequences on the BST composition, microstructure, and properties. In addition, various papers were presented describing systematic studies on resistance degradation behavior of BST capacitors. Differences in the resistance degradation behavior of films vs. bulk materials were demonstrated to depend on substrate temperature, electric field, and oxygen partial pressure during film processing. Extensive work on electrical characterization of PZT and SBT capacitors provided data to consistently explain the origin of the Curie-von-Schweidler behavior. Systematic studies on the effect of annealing on BST layers revealed that annealing in O_2 results in BST layers with higher dielectric constant and lower leakage current than those observed in BST capacitors annealed in N_2. Work was also reported on the evolution of Pt electrode surface morphology and on the effect of the state of stress of Pt bottom electrodes on BST capacitor performance.

Testing and Characterization

Work presented in the testing and characterization session demonstrated the power of atomic force microscopy to perform *in situ* nanoscale studies of polarization domain dynamics using a piezoresponse imaging technique. Initial studies demonstrated that polarization retention in highly oriented PZT films appears to be controlled by depolarization processes linked to grain boundaries between grains with opposite polarization direction. Initial AFM imaging provided nanoscale level evidence in support of prior macroscopic electrical measurements which indicated that fatigue in Pt/PZT/Pt capacitors may be controlled by domain pinning-depinning phenomena correlated with point defects in the ferroelectric layer and ferroelectric/ electrode layer interfaces. Work presented in this session provided new information to understand imprint. The data presented was interpreted as indicative that the voltage shift signature of imprint can be due to trapped or bulk screening charges at grain boundaries and electrode/dielectric interfaces. Initial studies of domain formation and switching in PLZT films via synchrotron X-ray XRD were presented. The results from these studies indicate that an important parameter affecting the domain structure is the transformation strain at the Curie temperature, which can be varied systematically by changing the concentration of La in the PLZT films.

SECOND DAY

The second day started with two plenary review papers. The first paper focused on the technology challenges and solution for 1Gbit DRAMs and beyond. The main challenges for future DRAMs remain cell size reduction, lithography and capacitor scaling, introduction of BST layers, and low cost manufacturing. The second plenary paper was a comprehensive review of electrical characterization of ferroelectric and superparaelectric thin films. It was shown that in the case of ferroelectric thin films, P-V and C-V measurements support the separation of reversible and irreversible contribution to the hysteretic part of the total polarization. In the case of $BaTiO_3$ films, it was

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shown that they may lose their hysteretic behavior and exhibit superparaelectric characteristics, depending on the grain size of the films.

NVFRAMs and Materials

An invited paper demonstrated that the Curie temperature $Ba_xSr_{1-x}TiO_3$ films can be changed by more than 100 ˚C. This modification appears to be induced by 2-D stresses caused by a lattice mismatch between the dielectric and the electrode layers. The BST films grown under these conditions exhibit polarization hysteresis loops. The authors argued that BST could be used for both NVFRAMs and DRAMs by tailoring the growth conditions to produce films with or without polarization hysteretic behavior. A contributed paper demonstrated a double metal level process which is indispensable for fabrication of embedded NVFRAMs. An Al_2O_3 ultrathin encapsulation layer was demonstrated, which can inhibit the reaction between PZT and intermetallic dielectric layers, providing a reliable fabrication process. Studies on imprint of PLZT capacitors revealed that electrode materials as well as compensation of oxygen vacancies influence imprint and fatigue, and therefore need to be carefully controlled. Work was presented on degradation of PZT capacitors. Standard characterization methods such as hysteresis loops, small signal capacitance measurements, and fast pulse switching tests were used to distinguish between reversible and irreversible contributions to the total polarization. Work on Nb doping of PZT films revealed that Nb doping reduces the coercive field and decreases the c/a ratio of the lattice due to microstructural changes in the 90˚ domains of PZT. PZT films with polarization saturation voltages of about 2 volts were demonstrated. A ferroelectric memory cell architecture for 4 to 16 Mbit NVFRAM was demonstrated.

High Frequency Devices Session

An invited paper was presented to review tunable microwave devices based on bulk and thin film ferroelectrics. It was demonstrated that the voltage and frequency dependence of ferroelectric thin films differ drastically from those characteristic of bulk materials. A sharp increase is observed in the dielectric loss of bulk materials with an applied DC field, while the dielectric loss of films exhibits a decrease. Tunable devices based on both bulk and thin film STO and BST integrated with high temperature superconducting electrodes were discussed. Another invited paper discussed voltage-tunable mixers and adaptive bandpass filters. A contributed paper demonstrated that doping of BST thin films with 1% Mn yields very good properties for tunable devices (k ~ 2100, 85% tunability at 88 kV, and a loss tangent ~ 0.0033). A contributed paper demonstrated that improved tunability and reduced loss can be obtained by careful control of dielectric film stochiometry and of strains resulting from the dielectric/bottom electrode layer interface. An interesting concept for a phase array antenna based on bulk phase shifting with ferroelectrics was presented. A discussion was presented about the challenges of frequency agile systems including ferroelectric materials. Ferroelectrics offer high tunability but currently exhibit RF losses that are too high for a commercial device. Methods for reducing losses were discussed. These methods include reduction of active site defects, utilization of the directional depen-

CRYSTAL GROWTH PAPERS

Melt Growth

Growth of heavily arsenic-doped silicon for the discrete semiconductor market
Philip Blosser, George Diercks, Roger Jones, Kim Mitchell, and Philip Yin

Si-GaAs, is the future here?
Douglas J. Carlson

Crystal growth in microgravity: Results from the growth of GaAs on the USML Spacelab Series
David H. Matthiesen

Growth of AIN single crystals
Glen A. Slack

Epitaxy and Surface Dynamics

On *in-situ* LEEM of GaN
E. Bauer

Annealing of nanostructures
Phillip M. Duxbury

SiGe island formation kinetics: Real-time studies of coarsening, shape transitions, and self-assembly
J. Floro

Phase transformations in metallic surface alloys
A.K. Schmid

In-situ atomic force microscopy studies of surface morphology and kinetics during the growth of $CaCO_3$
C. Orme, S. Orme, H.H. Teng, P.M. Dove, and J.J. De Yoreo

In-situ electron microscopy studies of surface dynamic processes
Ruud M. Tromp

Driving forces for self-assembly on

CRYSTAL GROWTH PAPERS

surfaces: Phonons in vacancy island lattices in Ag films on Ru (0001)
N.C. Bartelt, M.C. Bartelt, K. Pohl, J. de la Figuera, J. Hrbek, and R.Q. Hwang

Cluster-step and cluster-cluster coalescence: Postdeposition dynamics in Ag/Ag adlayers
C.R. Stoldt, A.M. Cadilhe, C.J. Jenks, J.-M. Wen, J.W. Evans, and P.A. Thiel

In-situ atomic force microscopy studies of the growth of crystals of 2,5-diketopiperazine
G.T.R. Palmore, M.T. McBride, M.M. Olmstead, T.A. Land, and J.J. De Yoreo

In-situ atomic force microscopy studies of surface morphology, growth kinetics, defect structure, and dissolution in protein crystallization
A.J. Malkin, Yu.G. Kuznetsov, and A. McPherson

Narrow Gap Materials
Novel VCSEL technologies for optical interconnect applications
Julius Cheng

In-situ diagnostics in the MOVPE growth of antimonide heterostructures
N.J. Mason

HgCdTe: The ultimate IR material
Sivalingam Sivananthan

OMVPE growth and characterization of GaInAsSb for thermovoltaics
Chris Wang

Wide Gap Materials
Lateral epitaxial overgrowth of selectively grown GaN layers and

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dence of the loss in ferroelectrics, and utilization of the paraelectric form of a ferroelectric, where a major contributor to losses (polarization) is absent.

Materials Processing-CVD
An invited paper discussed MOCVD of SBT films for NVFRAMs. This paper focused on CVD of SBT using a liquid delivery system to control film composition and impurity phases. Another invited paper described the state of the art in MOCVD of PZT, SBT, and BST using liquid delivery systems. A contributed paper demonstrated a low deposition temperature (~ 380 ˚C) MOCVD technique to grow SBT films for NVFRAMs. The main feature of the new technique was the use of a new Bi precursor, which allows control of film composition, run-to-run repeatability and thickness and composition uniformity over 6" substrates. As-deposited films exhibited 90% step coverage and good adhesion on $Pt/SiO_2/Si$ substrates. A low temperature MOCVD process was described, which uses plasma-enhanced growth. BST films were grown at 250-500 ˚C with a constant ECR power of 1000 W. It was shown that the dielectric constant of the films depends strongly on the deposition temperature, with a value of 281 for Ti-rich 83 nm thick films. Another contributed paper demonstrated a low temperature (525 ˚C) MOCVD method to grow PZT thin films on RuO_2 electrode layers on SiO_2/Si substrates, with controlled orientation. Highly (001) oriented PZT films were grown on (101)-textured RuO_2 bottom electrodes, while randomly (110)-(111) oriented PZT films were synthesized on (110) RuO_2 electrode layers.

Materials Processing-PVD
An invited paper discussed epitaxial and large area films grown by pulsed laser ablation-deposition. It was demonstrated that CeO_2/YSZ template layers can be used to grow epitaxial SBT films. The work was done on 3" substrates, and the films exhibited good thickness and composition uniformity. The conditions to grow single domain/single crystal $PbTiO_3$ (PT) films were discussed in another invited paper. It was demonstrated that single crystal PT films can be grown on (001) $SrTiO_3$ substrates with a miscut of 1.7˚, using RF-planar magnetron sputtering. The electrical properties of BST films produced by magnetron sputter-deposition were discussed in a contributed paper. It was demonstrated that the BST films grown by magnetron sputtering had a dielctric constant of 200 over the 50 MHz to 1 GHz frequency range. A contributed paper presented initial results from studies of metallic species and oxygen incorporation during sputter-deposition of SBT films, using a unique *in situ* time-of-flight ion scattering and direct recoil spectroscopy technique. It was shown that Ti and Si diffuse to the surface of a Pt layer in heterostructure $Pt/Ti/SiO_2/Si$ substrates used by many groups for NVFRAMs and DRAMs. The Ti and Si species inhibit the incorporation of Bi during the initial stages of sputter-deposition of SBT films at 650-700 ˚C. Lowering the substrate temperature allows to grow SBT films. Also, by using stable Pt/TiO_2 electrodes, where no diffusion of Ti nor Si to the Pt surface occurs, SBT films can be grown at any temperature in the room temperature-700 ˚C range. It was demonstrated that Ti and Si bind oxygen preferentially

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inhibiting the incorporation of Bi in SBT films deposited at ≥ 600 ˚C. Work on PZT films grown by magnetron sputter-deposition, for application to infrared detectors, demonstrated that PZT films can be grown at low temperatures (~450˚C) with controlled composition. Films grown under controlled conditions exhibited self-polarization, which can be used to fabricate infrared detectors without the need for poling the as-deposited films.
A contributed paper demonstrated the feasibility of growing c-axis and a-axis oriented SBT films by PLD. C-axis oriented films were grown on $LaAlO_3$-Sr_2AlTaO_6 substrates, while a-axis oriented SBT films were grown on (100) $LaSrAlO_4$ substrates.

THIRD DAY
The final day of the ISIF98 started with a plenary lecture on biomedical applications of ferroelectric MEMS. It was demonstrated that piezoelectric materials (both bulk and thin films) have been successfully integrated into two important classes of medical devices, namely bioanalytical microchips and surgical microinstruments. Specific devices demonstrated in the lecture included molecular recognition piezoelectric cantilevers, microfluidic pumps and valves for reagent control in genetic microchips, active tissue sensing using piezoelectric pressure and force sensors, and linear micromotor for precision surgery.

Piezoelectric and MEMS Applications
The impact of domain, dielectric, and electromechanical properties of ferroelectric thin films were discussed in an invited paper. The effect of film stresses on domain wall dynamics was discussed. Experimental results discussed in the talk indicate that the number of domains variants within a grain and the mobility of the twin walls depend on the grain size. It was found that for sol-gel and PLD PZT 40/60, 52/48, and 60/40 films < 1 μm thick, the extrinsic contributions to the dielectric and electromechanical properties make very modest contributions to the film response. A contributed paper discussed the electromechanical properties of piezoelectric PMN-PT films prepared by PLD. The importance of this material from the electromechanical point of view is that they have shown extremely high strain (~1.7%) in bulk crystal form. The maximum d_{33} observed for the films discussed in this paper were in the range 50-150 pC/N depending on the composition, thickness, and frequency. Another contributed paper discussed the dynamic polarization effects in compositionally graded PZT films. PZT films with Zr/Ti ratio gradients normal to the film surface were synthesized using PLD. These films exhibited a large polarization offset that increased monotonically with driving voltage and frequency. The magnitude of the observed offsets were nearly an order of magnitude greater than those observed in graded BST films. A comparison in the degradation characteristics of hard and soft PZT was presented. Hard PZT subjected to cyclic loading exhibited both microcracking and domain reorientation, which appears to be controlled by the temperature at which the loading occurs.

Pyroelectric and Optical Applications
State-of-the-art fabrication of pyroelectric imaging arrays was presented in a

CRYSTAL GROWTH PAPERS

dislocation density reduction
O.M. Am, T. Zheleva, and Robert F. Davis

Physical vapor transport growth of low defect SiC crystals
Richard H. Hopkins, V.J. Balakrishna, G.Augustine, G.T. Dunne, and R.N. Thomas

How to avoid hydrogen incorporation in MOVPE of ZnSe for efficient p-type doping
S. Irvine, M.U. Ahmed, and N. Maung

Oxides
Quartz on a commercial scale
J.F. Balascio

Characterization of optical performance and defect structure on rapidly grown crystals of KDP and DKDP
J.J. De Yoreo, M. Yan, M.J. Runkel, B.W. Woods, R.W. Ryon, L. Carman, N.P. Zaitseva, Z.U. Rek, L.W. Liou, and S.G. Demos

Growth of sapphire for optical and electronic applications
Milan R. Kokta

Capabilities, promises, and limitations of process modeling
Shariar Motakef

Defect formation during rapid growth of large (40-60 cm) KDP and DKDP crystals
N.P. Zaitseva, L. Carman, I.L.Smolsky, R. Torres, R. Ryon, and M. Yan

Growth of bulk, twin free photorefractive Ce:$Ba_{1-x}Sr_xTiO_3$ single crystals

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R. Varatharajan, R. Jayavel, C. Subramanian, and P. Ramasamy

Poster Session

Growth of InGaN/GaN device structures by multiwafer planetary metalorganic vapor phase epitaxy
M.D. Bremser, H. Protzmann, D.A. Schmitz, O. Schoen, M. Heuken, E.G. Woelk, and H. Juergensen

Comparative influence of Sn-doping on polytypism in vapor and solution grown CdI_2 crystals
Ritu Dhingra

Bridgman growth of barium sodium niobate
Gisele Foulon, Roger K. Route, Martin M. Fejer, Howard S. Lee, Robert J. Raymakers, and Robert S. Feigelson

Growth of InP crystals by the vertical gradient-freeze method with a submerged heater
G.W. Iseler, G.G. Bryant, and D.F. Bliss

Planar growth forms of cubic tetrahydrofuran clathrate hydrate: Stacking fault and other origines
Charles A. Knight, Kevin Rider, and E. Dendy Sloan, Jr.

Growth of KH_2PO_4 (100) and incorporation of impurities investigated by atomic force microscopy
T.L. Martin, T.A. Landa, G.T.R. Palmore, and J.J. De Yoreo

Growth of narrow gap IV-VI semiconductors on Si (100) using combination MBE and LPE
P.J. McCann, H.K. Sachar, I. Chao, C. Li, and X.M. Fang

Growth of lead magnesium niobate single crystals by the Bridgman method
Sang-Goo Lee, Howard S. Lee, Myeongkyu Lee, Ralph G. Monteiro, and Robert S. Feigelson

Comparative terrestrial and microgravity crystal growth of gallium and indium antimonide

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review paper. The system design provides the capability for device operation sensing radiation in the 8-14 μm wavelength. It was demonstrated that 80,000 pixel arrays on 50 μm centers are routinely prepared. Work on infrared detectors based on magnetron sputter-deposited PZT films was discussed in a contributed paper. A comparison was made between PZT film and copolymers-like based IR detectors. PZT films were synthesized at about 450 ˚C, which makes them suitable for integration in semiconductor based detectors. Copolymers can simplify the sensor fabrication procedure. However, the low Curie temperature limits their application to devices working at ≤ 70˚C in order to avoid depolarization. Gas sensors based on sol-gel BST thin films were also discussed. It was demonstrated that the high dielectric constant of BST thin films enhances the induced charge at the dielectric/electrode interface, which, for example, greatly improves the sensitivity to H_2 gas detection.

Materials Processing/Chemical Solution Deposition

The design routes for CVD precursors were discussed in an invited paper. The design of the solution chemistry provides control of film stresses, deposition conformality, phase evolution, and epitaxy. Another invited paper discussed recent developments on chemical solution deposition and liquid source misted chemical deposition methods to produce SBT thin films. A contributed paper discussed the synthesis of very thin PZT films which exhibit good electrical properties. It was demonstrated that control of the film orientation is critical for a successful thickness scaling. Control of the ratio of (111)/(100) phases can be used to produce 50 nm thick PZT films with saturation polarization achievable at 1.5 V. The preparation of highly (111) oriented PZT films with mixed composition was discussed as a means to produce PZT-based capacitors with square shaped P-E loops with large remanent polarization and low coercive fields. The PZT films consisted of first four layers of Ti-rich PZT (Zr/Ti=30/70) followed by two layers with morphotropic phase composition.

Conclusions

The ISIF98 provided a good overview of the progress on the science and technology of ferroelectric thin films and devices during the past ten years. Tremendous progress has occurred in the development of ferroelectric high dielectric constant thin films deposition techniques and in the synthesis of ferroelectric thin films and electrode layers, as well as in the development of materials integration strategies which can be used to produce ferroelectric capacitors with device-quality properties. In fact, low density embedded ferroelectric memories are being incorporated in commercial devices, such as cellular phones and smart cards. However, research is still needed to integrate ferroelectric capacitors into high density NVFRAM architectures, and high dielectric constant BST into DRAMs. Great progress has been made also in the synthesis of piezoelectric and pyroelectric thin films and their integration into MEMS devices and infrared detectors, respectively. Progress has also occurred in the application of high dielectric constant thin films to high frequency devices, although the relative number of researchers involved in this field has not been as large as in the case of ferroelectric

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memories. A more intensive effort may be directed toward high frequency devices since there will be a DARPA funded program, scheduled to start in 1998, to develop high dielectric constant thin films for integration into frequency agile devices. In addition, high dielectric constant thin films may play an even more important role in a whole new generation of microelectronic devices, since the road map for microelectronics indicates that research should be undertaken to replace the current gate oxides used in Si-based technology with high dielectric constant materials, BST probably being one of the candidate materials for second or third generation devices.

In view of the information presented above, the next ten years look very promising for the field of ferroelectric thin films and devices, and it is reasonable to assume that industry may be posed to dedicate more resources to introduce ferroelectric thin film-based devices into different markets.

– Orlando Auciello
Technical Program Chairman, ISIF 98
Argonne National Laboratory, Illinois

CRYSTAL GROWTH PAPERS

N. Audet, R.F. Redden, and W.F. Micklethwaite

Crystalline perfection and surface roughness of sapphire c-axis substrates
C.D. Moore, M.S. Goorsky, D. Reid, and H.L. Glass

Combined lattice parameter mapping and X-ray topography of SiC substrates
C.D. Morre, M.S. Goorsky, and M. Skowronski

Large diameter GaAs and InP substrates: Crystalline perfection
R. Sandhu, G. Bhasin, C.D. Moore, and M.S. Goorsky

ABOUT ISIF98 EXHIBITORS…

At the ISIF98 the center for technology transfer **aix*ACCT***, located in Aachen, Germany, presented a modular equipment for electrical characterization of electroceramic thin films. One of the modules is used for the analysis of the ferroelectric hysteresis of thin films. A second one is able to measure the response of integrated ceramic capacitors on a voltage step. The raise time and fall time is below 3ns, so that the system works similar as in the application of such capacitors.

Novtek Test Systems used the ISIF98 to announce an agreement with Symetrix Corporation to license their Othello ferroelectric material test software and instrumentation.
Novtek Test Systems specializes in the design and manufacturing of ferroelectric and nonvolatile memory test equipment. Products include Sawyer Tower testers, flash and EEPROM memory endurance cycling systems and production wafer sort systems.

Ferroelectricity Newsletter
including all back issues is available on Internet

http://www.sp.nps.navy.mil/projects/ferro/ferro.html

in Adobe Acrobat PDF file format

The PDF file format maintains the graphics and organization of the printed newsletter. Adobe Acrobat Reader is a helper application distributed free for Web browsers. Acrobat is available for Macintosh, Windows, DOS, SGI, and Sun SPARC operating systems.

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WILLIAMSBURG WORKSHOP

THE 1997 WILLIAMSBURG WORKSHOP ON FERROELECTRICS

Volume 206 Numbers 1-4 (1998) and Volume 207 Numbers 1-2 (1998) of ***Ferroelectrics*** contains the proceedings of the 1997 Williamsburg Workshop on Ferroelectrics, held in Williamsburg, Virginia, 2-5 February 1997. The proceedings contain 29 of the 40 papers presented at the 1997 Workshop, the largest in both the number of attendees involved and of papers presented since the first Williamsburg Workshop in 1990. The year 1993 marked a change in the organizational approach: in alternate years the emphasis has been placed on theories and experimental results, respectively. Every other year Ronald Cohen of the Carnegie Institute of Washington organizes the workshops to address the recent theoretical developments, while Haydn Chen of the University of Illinois at Urbana-Champaign and Takeshi Egami of the University of Pennsylvania organize the workshops focusing on experimental discoveries in ferroelectricity in alternate years.

The 1997 Williamsburg Workshop started off with three thematic presentations: Ronald Cohen, "First-Principles Studies," Eric Cross, "Relaxor Ferroelectrics," and Robert Bline, "Soliton Dynamics of Gemometrically Confined Ferroelectric and Antiferroelectric Liquid Crystals." They were followed by 35 oral presentation and two poster papers.

In his editorial, Haydn Chen, guest editor of the proceedings, says: "The1997 Williamsburg Workshop had two main focuses: relaxor ferroelectrics and geometrically confined ferroelectrics.

"Relaxor ferroelectrics are a class of materials in which imperfectly understood internal mechanisms prevent the development of full ferroelectricity. The substantial technical potential of relaxor ferroelectrics is manifest in their very large dielectric susceptibility and huge, tunable piezoelectricity, optical birefringence, and nonlinear optical properties. Two sessions of this workshop were devoted to this topic.

"Geometrically confined ferroelectrics refer to ferroelectric materials in the form of thin films, nano particles, or strained conditions so that the materials' microstructure and their corresponding properties are influenced by external confinements. The synthesis and processing properties in geometrically confined modes are of practical importance. The resulting structure and properties often exhibit unusual phenomena which are far from totally understood. Ten papers addressed this topic, including interfaces, size effects, and thin films of ferroelectrics."

First-principles study of piezoelectricity in tetragonal $PbTiO_3$
G. Sághi-Szabó, R.E. Cohen, and H. Krakauer

Soliton dynamics of geometrically confined ferroelectric liquid crystals
R. Blinc, I.Musevic, and M. Skarabot

Theoretical examination of stress fields in $Pb(Zr_{0.5}Ti_{0.5})O_3$
N.J. Ramer, E.J. Mele, and A.M. Rappe

Acoustic mode instabilities in ferroelectrics: Anharmonic mode-mode coupling induced by electron-phonon interactions
A. Bussmann-Holder

Electronic structures and the phase stability of perovskite-type oxides $KNbO_3$ and $KTaO_3$
M. Kitamura and H. Chen

First-pricniples calculations for Fe impurities in $KNbO_3$
A.V. Postnikov, A.I. Poteryaev, and G. Borstel

Applications of Tokhonov regularization to dipole glass relaxation function
B.-G. Kim and J.-J. Kim

Field-induced piezoelectric resonances in the superparaelectric phase of KTN
J. Toulouse and R. Pattnaik

Discriminating between the displacive vs. order-disorder character of a phase transition by magic angle spinning NMR
A.N. Klymachyov and N.S. Dalal

Threshold of irreversible domain wall motion in soft PZT-piezoceramic
V. Mueller and Q.M. Zhang

Crystal structure analysis and polarization mechanisms of ferroelectric tetragonal tungsten bronze lead barium niobate
R. Guo, H.T. Evans, Jr., and A.S. Bhalla

Precursor structures in ferroelectrics from first-principles calculations
H. Krakauer, R/ Yu, C.-Z. Wang, and C. Lasota

Ferroelectric transition in a random field: Possible relations to relaxor ferroelectrics
S. Semenovskaya and A.G. Khachaturyan

First-principles theory of structural phase transitions for perovskites: Competing instabilities
D. Vanderbilt and W. Zhong

Ab initio phonon dispersion curves and interatomic force constants of barium titanate
Ph. Ghosez, X. Gonze, and J.P. Michenaud

Lattice dynamics study on cubic barium titanate based upon a

WILLIAMSBURG WORKSHOP

modified rigid-shell model
N. Takesue, H. Kubo, and H. Chen

Nature of atomic ordering and mechanism of relaxor ferroelectric phenomena in PMN
T. Egami, W. Dmowski, S. Teslic, P.K. Davies, I.-W. Chen, and H. Chen

A domain wall model for relaxor ferroelectrics
I-Wei Chen and Y. Wang

A phenomenology of relaxor-ferroelectric phase transitions
B.E. Vugmeister and H. Rabitz

The influence of mobile vs. randomly quenched impurities on ferroelectric phase transformations
Q. Tan, J.-F. Li, and D. Viehland

Variation in the ordering of $Ba(Zn_{1/3}Tn_{2/3})O_3$ with a-site substitutions
C.-C. Lee, C.-C. Chou, and D.-S. Tsai

Transition dynamics in relaxor ferroelectrics
I.G. Siny and R.S. Katiyar

Finite size effects in $BaTiO_3$ ferroelectric glass ceramic
C.A. Randall, D.E. McCauley, and D.P. Cann

The role of interfaces on an apparent grain size effect on the dielectric properties for ferroelectric barium titanate ceramics
M.H. Frey, Z. Xu, P. Han, and D.A. Payne

Elastic property characterization in thin samples of sub-wavelength in thickness
W. Cao

Future issues in ferroelectric miniturization
J.F. Scott

Piezoeletricity in ferroelectric thin films: Domain and stress issues
S. Trolier-McKinstry, J.F. Shepard, Jr., J.L. Lacey, T. Su, G. Zavala, and J. Fendler

Structure control of pulsed laser deposited $Pb_{0.6}Sr_{0.4}TiO_3$/ $La_{0.5}Sr_{0.5}CoO_3$ thin films on various substrates
C.-C. Chou, C.-S. Hou, and H.-F. Cheng

Local structure and the phase transitions of $BaTiO_3$
B. Ravel, E.A. Stern, R.I. Vedrinskii, and V. Kraizman

PIEZOELECTRICITY AND PYROELECTRICITY DATABASE (PPDB)

The database used in Professor Sidney B. Lang's "Guide to the Literature of Piezoelectricity and Pyroelectricity" which appears semiannually in *Ferroelectrics* is now accessible on the Gordon and Breach Internet website.

The current version of the Piezoelectricity and Pyroelectricity Database (PPDB) contains references to most of the publications on piezoelectricity and pyroelectricity during the period 1990-1994, with a small number from 1995. The database will be updated with an additional 500-1000 new references about twice a year. In order to make the database as comprehensive as possible, references are included even if piezoelectricity and/or pyroelectricity formed a very minor part of the contents of the publication. The current database contains 8127 references.

References are given for articles in journals, chapters in proceedings or books, books, patents, theses, and reports. Full bibliographic information is given so that the reader can locate the publication. Additional information, such as conference presentation data, language (if other than English), and patent assignees is given where available.

The URL for accessing PPDB is http://www.gbhap-us.com/c3/lit_guide/

Information in the PPDB can be accessed in two ways: (1) Direct search of the database on the Internet or (2) Downloading of the entire database and a public-domain search engine to the user's computer. Full instructions are supplied.

Any problems with the PPDB or suggestions should be sent to:

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UPCOMING MEETINGS

IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP98)
25 - 28 October 1998
Atlanta, Georgia

The Conference on Electrical Insulation and Dielectric Phenomena (CEIDP) is sponsored by the IEEE Dielectrics and Electrical Insulation Society to provide an international forum for the discussion of work in progress on research on dielectric phenomena and measurements. The conference provides an opportunity for specialists from around the world to exchange their experience.

Topics

- Aging dielectrics
- Surface flashover
- Polarization phenomena
- Measurement techniques
- Partial discharge measurements
- Flow electrification
- Charge storage and transport
- Electrohydrodynamics
- High-field effects
- Charge and field mapping
- Treeing
- Prebreakdown and breakdown in solids, liquids, gases, and vacuum

Whitehead Memorial Lecture

The 1998 Whitehead Memorial Lecture, "Optical, electrical, and electromechanical measurement methodologies of electric field, charge, and polarization in dielectrics," will be given by Prof. Markus Zahn of the Massachusetts Institute of Technology.

If your company is interested in participating as an exhibitor, please contact
Dr. Joachim Vinson, NOVOCONTROL Amercia, Inc.
611 November Lane/Autumn Woods, Willow Springs, NC 27592-7738
phone +919-639-9323; fax +919-639-7523; e-mail vinson@ntwrks.com

Session EM12: Processing of High Dielectric Constant Materials for DRAMs
45th International Symposium of the American Vacuum Society
2 - 6 November 1998
Baltimore, Maryland

In recognition of the growing importance of high dielectric constant materials to the semiconductor industry, the organizers of the AVS have established a new session devoted strictly to the processing of high dielectric constant materials.

The minimum feature size requirement for 1Gbit and 4 Gbit DRAM generations falls into the deep submicron range. The ability to fabricate acceptable DRAM charge storage elements within this size regime, utilizing traditional materials, has become a matter of great concern within the research and development community. For the past quarter century, the semiconductor industry has fabricated DRAM charge storage elements with a dielectric layer consisting

UPCOMING MEETINGS

of silicon dioxide and/or silicon nitride sandwiched between polysilicon or doped silicon electrodes. It is questionable whether a capacitor that meets the 1Gbit/4Gbit DRAM charge storage needs can be manufactured with these materials at such small dimensions. In recent years the perovskites, a family of high dielectric constant materials, have been attracting considerable interest for use in DRAM capacitor structures due to their excellent charge storage properties.

Topics

- Electrode patterning (e.g., utilization of novel gas mixtures; adaptation of hard mask materials; computer modeling of etch processes; deep submicron etch results; and electrode size effects on electrical properties)
- Conformal dielectric coatings at submicron dimensions
- Barriers resistant to O_2 and Si diffusion
- Electrode-dielectric interactions
- Dielectric-barrier interactions
- Methods of studying electrode-barrier interactions
- Novel use of strained epitaxial layers to enhance dielectric properties
- Influence of dielectric film preparation methods (e.g., sputtering, MOCVD, or sol-gel) on film thickness, composition, and grain size/orientation
- Understanding process results through electrical measurements of dielectric properties
- Influence of dielectric film surface preparation on processing and dielectric properties

Contact

Keith Milkove, phone +914-945-2878; e-mail milkove@us.ibm.com

Check out the AVS on the web: http://www.vacuum.org

Micro System Technologies 98
6th International Conference and Exhibition on
Micro Electro, Opto, Mechanical Systems and Components
1 - 3 December 1998
Potsdam, Germany

This biannual international event is one of the most important conferences and exhibitions in the fields of research, development, and manufacturing of microsystems, providing important and timely results on materials science, engineering, technology, and application of microsystems. It will stimulate new developments by bringing together and cross-linking the knowledge and experience of specialists from research and industry. Thus it will encourage the development of new technologies and applications to achieve the economical and ecologically sound production of reliable, high performance microsystems.

Microsystems applications are integrated in all aspects of society, promising to improve our quality of life. Today the combination of micro technologies is one of the main pillars of economic health and success. It delivers the basis to minimize our existing products and to improve their reliability as well.

Microsystem technologies offer the conception of mobile products by integrating autonomous energy systems and by linking the products to local and worldwide networks. This is an emerging field with strong international research activity, increasing applications in a variety of industries, including information processing, communication systems,

UPCOMING MEETINGS

automotive and transportation, consumer products, medical and biological technology, and environmental control.

The development of microsystems also brings about many challenges, from the fundamental understanding of physics, chemistry, and mechanics of microstructures to the fabrication technology needed to integrate electrical, chemical, and biological subsystems, and to the design and packaging processes of micro components and systems.

Topics

- Characterization and testing
- Component and system design, reliability modeling
- Micro materials and properties
- Process technologies
- Advanced packaging and interconnections
- Microoptical and microfluidic devices
- Sensors and actuators
- Biology based approaches
- MST based displays
- Integrated power supply and storage in module systems
- Wireless links of microsystems
- Assembly and microintegration
- Applications and markets in different industrial branches
- Product visions

Contact

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NEW MRS PUBLICATIONS

Third Volume Added to New Series on Low-Dielectric Constant Materials III

The third in a new series from the Materials Research Society (MRS), *Low-Dielectric Constant Materials III*, documents symposium reports from the 1997 MRS Spring Meeting in San Francisco, California, and contains 40 papers, 300 pages.

Continuing improvement of integrated circuits critically depends on the use of nonconventional materials. Interconnect delay is already the most severe limiting factor in most advanced ICs. This delay can be minimized by reducing the interconnect capacitance, which is determined by a combination of process architecture and materials. While a broad range of candidate materials is being explored for IC application, there is no clear consensus on what materials will be used to replace SiO_2. Process architectures are also unsettled, with various efforts directed to either evolving present-day technology or switching to a damascene metal approach. Yet these processes may not be scaleable beyond the 0.15μm generation of IC technology. Thus there still exists a need for basic understanding of interconnect materials and the limits of interconnect technology. This volume brings together experts in the field of low-k dielectrics to focus on the challenges ahead. Topics include organic and inorganic dielectrics; interfaces and porous materials; measurement and characterization; vapor-deposited materials; fluorinated oxides and polyimides.

Low-Dielectric Constant Materials III is Volume 476 in the MRS Symposium Proceedings Series. It is available in hardcover or microfiche for $57.00 (MRS members), $66.00 (US List), and $76.00 (Non-US List).

MRS PUBLICATIONS

New Volume from MRS Explores Magnetic Ultrathin Films

The central thrust of this new volume from MRS, containing 87 papers, 630 pages, is the relationship of magnetic properties and device performance to structure in atomic, nanometer, and submicron length scales. Emphasis is placed on advances in synthesis and characterization, including theoretical and computational treatments applied to model systems and to device structures like spin valves, CMR and GMR materials. Results from diverse experimental tools and from many theoretical and computational approaches are organized around areas of magnetic and magnetotransport phenomena and their applications. Topics include synthesis, processing and characterization, novel applications and approaches for magnetism, nano/microstructure and magnetic properties, structure and properties–mixing, strain and steps, nanoscale magnetic confinement, particles and arrays, magnetization reversal and domain structure, synchrotron radiation studies of magnetic materials, magnetooptic properties, effects and measurements, magnetic phenomena–theory and experiment, spin-dependent transport–CMR and tunneling, and interlayer coupling and spin polarization.

Magnetic Ultrathin Films, Multilayers and Surfaces, Volume 475 in the MRS Symposium Proceedings Series, is available in hardcover or microfiche for $65.00 (MRS members), $75.00 (US List), and $86.00 (Non-US List).

Symposium Reports Examine Advances in Polycrystalline Thin Films

Published by MRS, *Polycrystalline Thin Films–Structure, Texture, Properties and Applications III* documents symposium reports from the 1997 MRS Spring Meeting in San Francisco and contains 71 papers, 474 pages.
Thin films are used in virtually every manufacturing and technological area. A large fraction of these films are polycrystalline. Their uses range from critical components in the microelectronics industry to hard coatings for wear resistance, corrosion resistance and thermal barriers to magnetic, optical, and medical applications. It is essential to the functional properties of these films that the microstructure, composition, architecture, and stress state be produced with a high level of control. To that end, success demands a detailed understanding of the fundamental mechanisms which are responsible for the formation and evolution of structure in polycrystalline thin films. This new volume focuses on thin polycrystalline metallic, ceramic, and semiconducting films of thicknesses in the range of tens to thousands of nanometers. Topics and investigations are interdisciplinary in nature and range from fundamental to technological. Topics include evolution of texture and microstructure; grain boundaries and interfaces; microstructure, stress and texture; characterization and representation; microstructure, texture, and reliability; processing, characterization, and application; and polycrystalline Si and SiGe films.

Polycrystalline Thin Films–Structure, Texture, Properties and Applications III, Volume 472 in the MRS Symposium Proceedings Series is available in hardcover or microfiche for $65.00 (MRS members), $75.00 (US List), and $86.00 (Non-US List).

1998 MRS Publications Catalog Supplement Now Available

The *1998 Materials Research Society Publications Catalog Supplement,* containing 68 new books–all exploring interdisciplinary research on advanced materials–is now available. The volumes span many subject areas, including biomedical materials, catalysts, ceramics and composites, computational methods, electronic materials and processing, education, glasses and insulators, materials characterization, metals and alloys, novel processing/applications, nuclear waste management, polymers, sensors, and more.

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The complete *1998 Materials Research Society Publications Catalog,* listing more than 530 books, plus databases, videotapes, and journals, is also available from the same address.

CALENDAR OF EVENTS

Jun 23-26	•	2nd International Seminar on Relaxor Ferroelectrics (ISRF-II), Dubna, Russia (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 12)
Jul 19-22	•	Innovations in Materials Conference (IMC), Washington, DC, USA (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 13)
Jul 26-31	•	12th International Conference on Crystal Growth and 10th International Conference on Vapor Growth and Epitaxy, Jerusalem, Israel (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 14)
Aug 24-27	•	11th International Symposium on Applications of Ferroelectrics (ISAF XI), European Conference on Applications of Polar Dielectrics (ECAPD IV), and Electroceramics VI, Montreux, Switzerland (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 15)
Aug 24-27	•	4th International Conference on Electronic Materials (IUMRS-ICEM-98). Cheju, Korea (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 16)
Sep 5-16	•	International School on Science of Crystal Growth Technology, Beatenberg, Switzerland Dr. Hans J. Scheel, Ecole Polytechnique Federale de Lausanne, Cristallogenese, Ch. de Bellerive 34, CH-1007 Lausanne, Switzerland, phone: +41-21-693-4452; fax: +41-21-693-4750; e-mail: hans.scheel@imo.dp.epfl.ch
Sep 20-23	•	3rd International Meeting of Pacific Rim Ceramic Societies (PacRim 3), Kyongju, Korea (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 17)
Oct 5-7	•	4th International Conference on Intelligent Materials (ICIM'98), Chiba, Japan (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 16)
Oct 25-28	•	IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP98), Atlanta, Georgia, USA (see p. 12)
Nov 2-6	•	45th International Symposium of the American Vacuum Society, Session EM12: Processing of High Dielectric Constant Materials for DRAMs, Baltimore, Maryland, USA (see p. 12)
Dec 1-3	•	Micro System Technologies 98, Potsdam, Germany (see p. 13)
Dec 8-11	•	2nd Asian Meeting on Ferroelectrics, International (AMF-2), Singapore (see *Ferroelectricity Newsletter,* Vol. 5, No. 4, p. 18)